

REMEDIATION

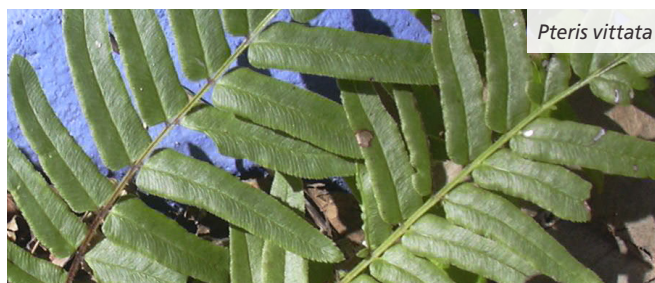
The Gene behind Arsenic Hyperaccumulation

Pteris vittata (brake fern) has been shown to accumulate large amounts of arsenic taken up from soil,¹ in one study removing more than a quarter of the soil arsenic within 20 weeks.² Now researchers have isolated the gene responsible for this feat: *ACR3*, which encodes a protein that pumps the metal into the vacuoles of plant cells.³ “Plants sequester toxicants in these vacuoles—we call them the plant’s trash can,” says principal investigator Jo Ann Banks, a professor of botany at Purdue University.

ACR3 is an arsenite efflux transporter gene found only in gymnosperms (nonflowering plants).³ Banks and horticulturist David Salt, also of Purdue University, identified *ACR3* in *P. vittata* by using a mutant yeast strain that lacks *ACR3* and dies when exposed to arsenic. The team inserted thousands of genes from *P. vittata* and found the one that corrected the deficiency, allowing the mutant to tolerate arsenic. They also showed that arsenic exposure stimulated *ACR3* activity. Fern gametophytes grown in an arsenic-laced medium produced 35 times more *ACR3* transcripts than those grown without arsenic. Moreover, ferns grown hydroponically in arsenic medium confirmed that *ACR3* activity was also highly induced in the roots.

As for what happens when the arsenic-laden plants die, Banks says, “The plants are ashed or composted to reduce biomass. There are a few labs researching how to convert the leftover arsenic into nontoxic organic arsenic compounds.”

Ferns are not the only plants that sequester arsenic. Crops such as rice have been shown to accumulate levels of arsenic high enough to threaten human health,⁴ making it important to learn how plants transport, store, and tolerate arsenic. Such information could lead to ways to manipulate rice plants to restrict arsenic to the roots and prevent contamination of edible grains. “Or we may even devise a way to keep rice plants from taking up arsenic at all,” says Banks.



Pteris vittata

“If this gene can be cloned into problematic crops such as rice, arsenic burdens in edible parts may be greatly reduced,” agrees Andrew Meharg, chair of biogeochemistry at the University of Aberdeen, United Kingdom. He adds that the new study “is a major advance in our understanding of how plants that concentrate high levels of arsenic are able to tolerate the toxic element.”

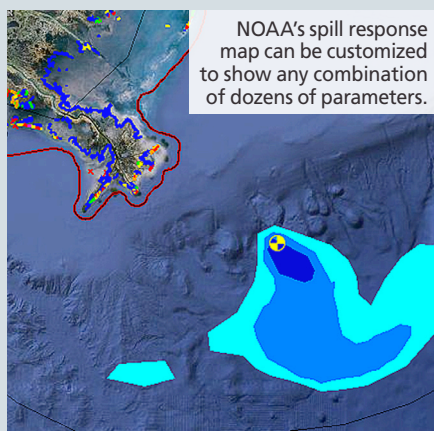
Landscapers currently plant *P. vittata* to clean up soils contaminated with arsenic from pesticides and pressure-treated lumber.⁵ However, the fern naturally grows only in warm climates such as Florida. Perhaps cold-tolerant plants could be programmed with *ACR3* to hyperaccumulate arsenic, too. Joseph Graziano, a professor of environmental health at Columbia University in New York City, notes, “It seems possible that the discovery of this gene could lead to the creation of genetically modified plants or trees with the ability to remove significant amounts of arsenic from contaminated soils.”

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Forest Starr & Kim Starr



in partnership with other agencies and stakeholders to offer near real-time data on the federal response to the *Deepwater Horizon* oil spill in the Gulf of Mexico. Visitors can use an interactive map to plot the latest available information about the spill’s trajectory, fishery closures, wildlife data, and locations of deployed research vessels. The map also highlights coastal areas where oil and tar balls have been observed

and gives details about the extent of these problems and the environmental sensitivity classification of the affected areas.

EPA Proposes New Power Plant Pollution Regs

Emissions from power plants can be transported hundreds of miles, affecting the health of populations far from the pollution’s source. The U.S. EPA has proposed regulations to curb emissions of sulfur dioxide and nitrogen oxides at their source.⁴ The proposed regulations would take the place of the 2005 Clean Air Interstate Rule, which the DC Circuit Court ordered the EPA to revise in 2008. The proposed regulations outline three possible approaches for emissions reductions, all of which involve some version of a cap-and-trade system.

Oil Spills May Affect Seawater Arsenic Levels

Recently published work suggests oil pollution may render the seafloor unable to filter out arsenic that occurs naturally

in the ocean and is introduced by drilling operations and oil spills.⁵ Sediments on the seafloor naturally bind arsenic, removing it from seawater. The authors of the new laboratory study found that low pH levels in seawater created a positive charge on samples of goethite (an iron oxide that is one of the most abundant compounds in ocean sediments), which then attracted negatively charged arsenic. Adding oil to the water created a physical barrier on the goethite and weakened the attraction between the two minerals. If oil pollution causes similar effects in ocean waters, the authors speculate arsenic may concentrate in the food chain to potentially harmful levels.

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